Frontiers in Air Quality Advances in Air Quality Toxicology

Fumifugium 2014

Ian Mudway



Cleaner Fuels (wood vs. coal) Separate population from pollution sources Economic benefits Green infrastructure

FUMIFUGIUM: The Inconveniencie of the AER AND SMOAK of LONDON DISSIPATED. TOGETHER With fome REMEDIES humbly PROPOSED By J. E. Efq; To His Sacred MAJESTIE, To the PARLIAMENT now Affembled.

Publifbed by His Majeffies Command.

Lucret. I. 5. Carbonúmque gravis vis, atque edor infinuatur Quam facile in cerebrum?

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John Evelyn 1620 – 1706



One very large seething Petri dish

Know your model organism







Think about susceptibility

Deaths Registered in London Administrative County Classified by Age (Bates, 1995)												
	< 1 Month of Age	1-12 Mo. Old	1-14 Years of Age	15-44 Years of Age	45-64 Years of Age	65-74 Years of Age	75+ Years of Age					
Week Before the Episode	16	12	10	61	237	254	335					
Week After the Episode	28	26	13	99	652	717	949					
Before/ After Episode Ratio	1.75	2.17	1.3	1.62	2.75	2.82	2.83					

Vulnerability

"This cloud is so inextricably mixed with the naturally wholesome and excellent air that the inhabitants can breathe nothing but thick, dirty, smoggy air. This makes them <u>vulnerable</u> to thousands of diseases, <u>corrupting their lungs</u> and disordering their bodies, so that catarrh, coughs and tuberculosis."



Critical windows of enhanced vulnerability

Degradation of defence mechanism with age

REPODUCTIVE AGE



MRC-PHE Centre for Environment & Health

Public Health England



In utero

Appreciate varying genetic background: An ethnically diverse city





"This plague of a smoke is truly intolerable because, although it does not kill at once, it is deadly and to slowly perish is worse than death itself. Is there any other place on Earth where such coughing and snuffling is to be heard as in the churches and assemblies of London, where the barking and spitting is incessant? Need I say more?"



Role of air pollution in chronic disease



"There are, I must accept, certain differences in people which allow them to thrive more in some airs compared to others."



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Impaired lung growth

Gauderman et al, 2004 (NEJM); southern California

- 1,759 10-yr old children, 12 communities, 8-yr follow up
- Lung function growth significantly reduced in areas with higher levels of traffic-related pollutants
 - NO₂, PM_{2.5}, elemental carbon (EC) associated with reduction in growth of FEV₁ of between 79.7 and 101.4 mL
 - Clinically low FEV₁ at age 18 positively correlated with level of exposure to NO₂, PM₁₀, PM_{2.5}, EC

Gauderman et al, 2007 (Lancet); southern California

-Same study, local vs. regional pollutant levels -Living <500m from freeway associated with reduction in FEV₁ growth of 81mL (vs. living >1500m away) -Significantly lower attained FEV₁ by 18 yrs

Pollution in Tower Hamlets & Hackney



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Modelled annual NO₂ concentrations



Gehring U, et al. Environ Health Perspect. 2013;121(11-12):1357-64.

Context



"There are, I must accept, certain differences in people which allow them to thrive more in some airs compared to others."



Genetic Modification

Xenobiotic metabolism:

• CYP1A1, GSTM1, GSTT1, GSTP1, EPHX1, NQO1, AhR

Antioxidant defence:

• GCL, ECSOD, Nrf2

Nitrosative stress:

• iNOS, ARG1, ARG2

Onset of childhood asthma

• GSDMA, GSDMB

Random ancestry markers:

• Adjust for population stratification and predict lung function as proxy for ethnic group



Quantifying exposure BIOMARKERS

1

2

3

7

Air in

1 IA		Traffic related metals												18 VIIIA			
H 1 1.008 Hydrogen	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	He 2 4.00 Helium
Li 3 6.94 Lithium	Be 4 9.01 Beryllium										\$	B 5 10.81 Boron	6 12.01 Carbon	N 7 14.01 Nitrogen	0 8 16.00 0xygen	F 9 19.00 Fluorine	Ne 10 20.18 Neon
Na 11 22.99 Sodium	Mg 12 24.31 Magnesium	3 IIIB	$_{IVB}^{4}$	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	A1 13 26.98 Aluminum	Si 14 28.09 Silicon	P 15 30.97 Phosphorus	S 16 32.07 Sulfur	C1 17 35.45 Chlorine	Ar 18 39.95 Argon
K 19 39.10 otassium	Ca 20 40.08 Calcium	Sc 21 44.96 Scandium	Ti 22 47.88 Titanium	V 23 50.94 Vanardium	Cr 24 52.00	Mn 25 54.94 Manganese	Fe 26 55.85	Co 27 58.93 Cobalt	Ni 28 58.69 _{Nickel}	Cu 29 63.55	Zn 30 65.39 7inc	Ga 31 69.72 Gallium	Ge 32 72.61	As 33 74.92	Se 34 78.96 Selenium	Br 35 79.90 Bromine	Kr 36 83.80 Krypton
Rb 37 85.47 Rubidium	Sr 38 87.62 Strontium	Y 39 88.91 Yttrium	Zr 40 91.22 Zirconium	Nb 41 92.91 Niobium	Mo 42 95.94	Tc 43 (97.9) Technetium	Ru 44 101.07 Ruthenium	Rh 45 102.91 Rhodium	Pd 46 106.42 Palladium	Ag 47 107.87 Silver	Cd 48 112.41 Cadmium	In 49 114.82 Indium	Sn 50 118.71	Sb 51 121.76	Te 52 127.60 Tellurium	I 53 126.90 Iodine	Xe 54 131.29 Xenon
CS 55 132.91 Cesium	Ba 56 137.33 Barium	La 57 138.91 Lanthanum	Hf 72 178.49 Hafnium	Ta 73 180.95 Tantalum	W 74 183.85 Tungsten	Re 75 186.21 Rhenium	Os 76 190.2 Osmium	Ir 77 192.22 Iridium	Pt 78 195.08 Platinum	Au 79 196.97 Gold	Hg 80 200.59 Mercury	T1 81 204.38 Thallium	Pb 82 207.2 Lead	Bi 83 208.98 Bismuth	Po 84 (209) Polonium	At 85 (210) Astatine	Rn 86 (222) Radon
Fr 87 223.02 Francium	Ra 88 226.03 Radium	Ac 89 227.03 Actinium	Rf 104 (261) Rutherlordium	Db 105 (262) Dubnium	Sg 106 (263) Seaborgium	Bh 107 (262) Bohrium	HS 108 (265) Hassium	Mt 109 (266) Meitnerium	Unnamed Discovery 110 Nov. 1994	Unnamed Discovery 111 Nov. 1994	Unnamed Discovery 112 1996		Unnamed Discovery 114 1999		Unnamed Discovery 116 1999		Unnamed Discovery 118 1999
223.02 Francium	226.03 Radium	227.03 Actinium	(261) Rutherlordium	(262) Dubnium	(263) Seaborgium	(262) Bohrium	(265) Hassium	(266) Meitnerium	110 Nov. 1994	111 Nov. 1994	112 1996		114 1999		116 1999		



Biomarkers out



PM₁₀ Metals (Fe and Cu)





PM₁₀ Metals (Ba and Mn)



PM₁₀ Metals (Cr and V)



Cleaner Fuels (diesel) Separate the vulnerable population from pollution sources **Economic benefits** Green infrastructure Moral imperative

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"I have made this proposal for refining the quality of air in London because I believe that we should do whatever we can to enhance the honour of our nation that is capable of such greatness. <u>It troubles me</u> <u>that the health and happiness of so many people should suffer from</u> <u>the greed of a few in a city that contains enough to make its people</u> <u>the happiest on Earth</u>. Money has blinded people to the thing which keeps them alive and which can, for their own sake, be improved so easily."

Omnia explorate; meliora retinete

